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NOISE MEASUREMENTS OF THE JET AND PISTON ENGINES ON THE LALA-1 EXPERIMENTAL AIRPLANE

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Translation of "Pomiary halasu silnika odrzutowego i tłokowego w samolocie doswiadczalnym Lala-1," Technika Lotnicza i Astronautyczna, Vol. 29, Feb. 1974, pp. 15-17

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16. Abstract

Results of noise measurements conducted on the ground and in the cabin of an experimental agricultural biplane Lala-1 during operation of either a jet engine or a piston engine on the aircraft. The locations and mounting of the two engines differed, and the measurements served not for purposes of strict comparison but as a basis of evaluating noise reduction possibilities offered by a jet engine. Isosonic curves and curves of amplitude vs. frequency (31.5 Hz to 31.5 kHz) are illustrated for both engines.

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NOISE MEASUREMENTS OF THE JET AND PISTON ENGINES ON THE LALA-1 EXPERIMENTAL AIRPLANE

A. Rudiuk

Independently of its basic mission, which was research into the use of a jet engine in an agriculture aircraft, the Lala-1 experimental airplane served in many other research applications, among others, a comparative study of noise in the use of jet and piston engines in the same fuselage. Frankly, this comparison was not ideal because conditions of mounting and fixing of the engines were not identical, but, for the intended purpose, they provided a relative similarity of conditions of placement of the acoustic cabin. /15*

Comparisons were made of noise produced by both sources, inside and outside the cabin. A precise type 2203 noise level gauge with a type 1316 octave filter, both from the firm Bruel Kjaer, was used for measurements. A general view of the noise measurement equipment outside the Lala-1 is shown in Fig. 1.

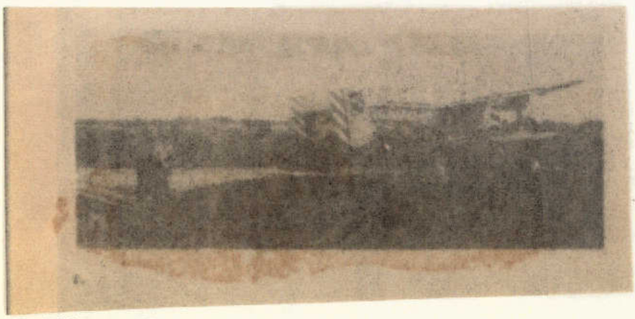

Fig. 1.

On the graph (Fig. 2) are given comparisons of a spectral analysis in octave bands, from the outside of the closed cabin of the plane, on a working AI-25 jet engine and an ASz-62 piston engine, under conditions corresponding to actual flight. For this, the standard accepted levels were used: 40% nominal rotary speed for the jet engine and 1850 rpm at 750 mm Hg pressure for the piston engine. From the graph it can be seen that the noise level in the

* Numbers in the margin indicate pagination in the foreign text.

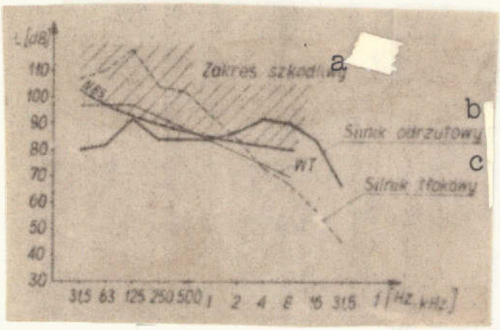

Fig. 2. Comparison of noise measurements in the cabin of the aircraft with a working piston engine (1850 rpm) and jet engine.

Key: a. Damaging range; b. Jet engine; c. piston engine

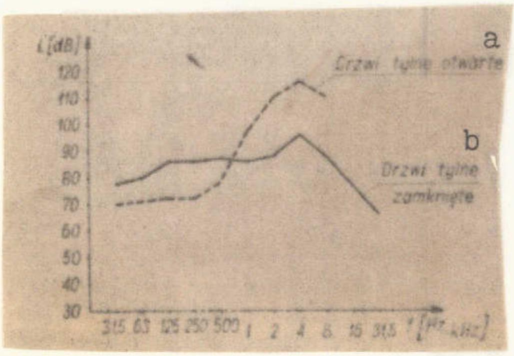

Fig. 3. Comparison of noise measurements in the cabin of the aircraft with working jet engine under actual flight conditions at 40% nominal speed.

Key: a. Rear door open; b. Rear door closed.

cabin is higher with the piston engine. With the piston engine, the predominant audible component is in the lower frequencies, with a maximum at 125 Hz, while, with the jet engine, the distribution is more uniform with a slightly greater concentration in the higher frequencies. There are two peaks here: 125 Hz and 4000 Hz. Comparison with the permissible noise level curve N85 shows an excess for both engines used; however, it is greater with the piston engine. For the jet engine, not only is the noise level lower, but, moreover, the high noise component is easier to control in the high frequency range in view of better isolation properties and greater sound absorption of the materials used.

The average (linear) noise leve of the piston engine is 115 dB, whereas, with the jet engine, it is 97 dB.

The principal object of this test was not so much comparative analysis in itself, but, first of all, assessing of the noise level and obtaining perspectives on its abatement, in connection with projected jet engine use in agricultural aviation.

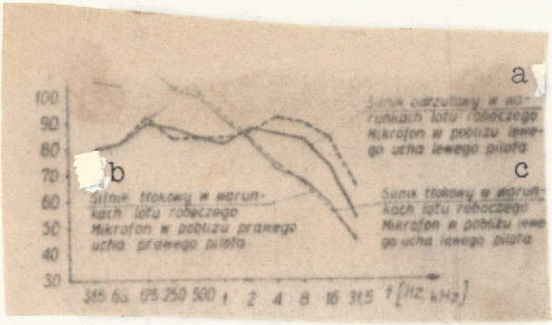

Fig. 4. Comparison of noise measurements in the cabin for right and left ear of pilot (from right and left side of main pilot).

Key: a. Jet engine under working flight conditions. Microphone near pilot's left ear; 2. Piston engine under working flight conditions. Microphone near copilot's right ear; c. Piston engine under working flight conditions. Microphone near pilot's left ear.

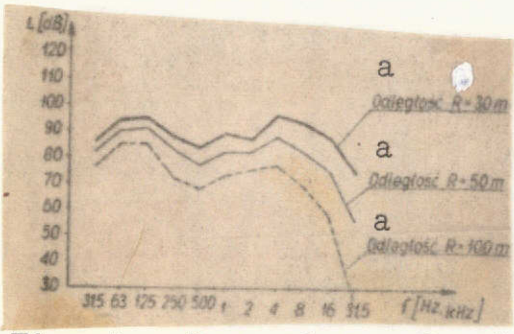

Fig. 5. Comparison of noise measurements outside the aircraft with working jet engine for various distances in the 225° sector.

Key: a. Distance ...

Figure 3 gives the noise comparison of a jet engine under working flight conditions with the rear cabin door open and closed, with the pilot isolated from the rear part of the fuselage, in which the jet engine is located. These doors are made of durable sheet metal (without insulation). From the graph one can draw two immediate conclusions concerning the sound-absorption properties of the cabin and /16
the isolation provided by the rear wall. The first result, a seemingly unlikely phenomenon, is that, up to a frequency of about 500 Hz, the noise diminishes after opening the door. However, this exists because of a strong reverberation which exists in the cabin, particularly in the low-frequency range. When the door is opened, the acoustic absorption of the cabin is increased (the "open window effect"), and the slight break in the hermetic seal decreases the possibility of the establishment of standing waves.

The second conclusion concerns an appraisal of the isolation qualities of the door. The differences in noise level in both instances indicate that the rear wall is of great consequence in

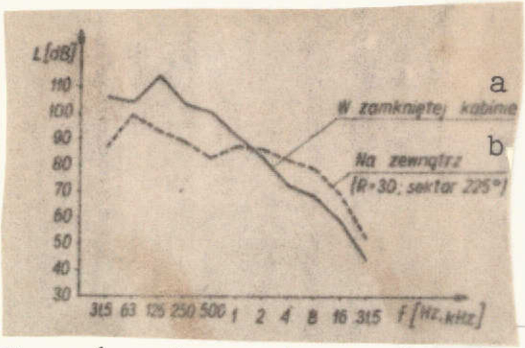

Fig. 6. Comparison of noise measurements in the cabin and outside the aircraft with running piston engine under working flight conditions.

Key: a. In the closed cabin; b. Outside (R = 30; sector 225°)

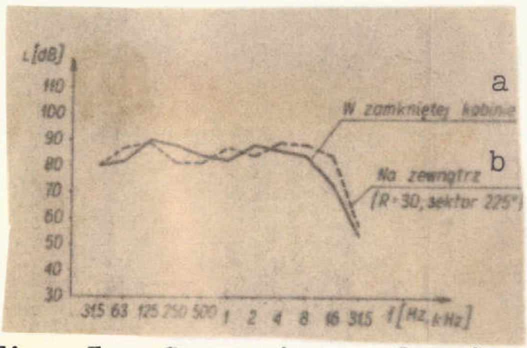

Fig. 7. Comparison of noise measurements in the cabin and outside the aircraft with running jet engine under working flight conditions.

Key: a. In the closed cabin; b. Outside (R = 30, sector 225°)

cabin isolation. Generally, the known law is confirmed that the low frequencies are the most difficult to isolate and damp. Throughout this research, the asymmetric sound amplification of the cabin was also specified. The off-center location of the air intake of the jet engine, like the exhaust pipe on the right side of the piston engine, is audibly reflected in the difference in noise levels between positions to the left and to the right of the pilot. This phenomenon is illustrated by the graph (Fig. 4). With both the working piston engine and the jet engine, the noise is greater on the right side. On the graph for the piston engine, the acoustical asymmetry of the cabin is shown in the low frequencies, while for the piston engine it is shown in the higher frequencies. This results from the nature of the exhaust in the piston engine, and the nature of the [illegible] roar at the jet engine intake.

[Several lines missing from original] ... which indicates greater damping of the higher components by air and ground.

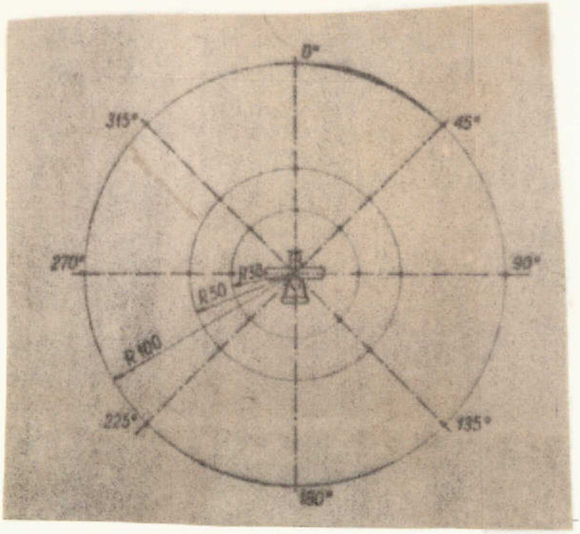

Fig. 8. Arrangement of measuring points outside the plane.

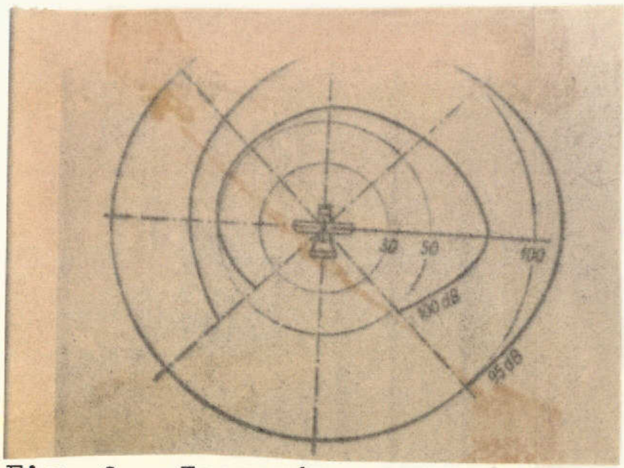

Fig. 9. Isosonic curves surrounding the plane with working piston engine under actual flight conditions.

In Figs. 6 and 7 are shown the different characteristics of the noise spectrum in the cabin and outside the plane. Fig. 6 refers to piston propulsion and Fig. 7 to jet propul- /17 sion. The comparison was carried out under actual flight conditions. Noise outside the plane was measured at a distance of 30 m, from which only spectral distributions were comparable, not proportional levels.

Fig. 8 presents the arrangement of measuring points for the noise research conducted outside the plane (on the ground).

In Fig. 9 are given the results of these tests for a piston engine under actual flight conditions.

The arrangement of the isosonic curves presented that results from line measurements (general measurements) confirms an acoustically asymmetric aircraft, which was also shown by measurements of noise from outside the cabin. For the jet engine, the arrangement of

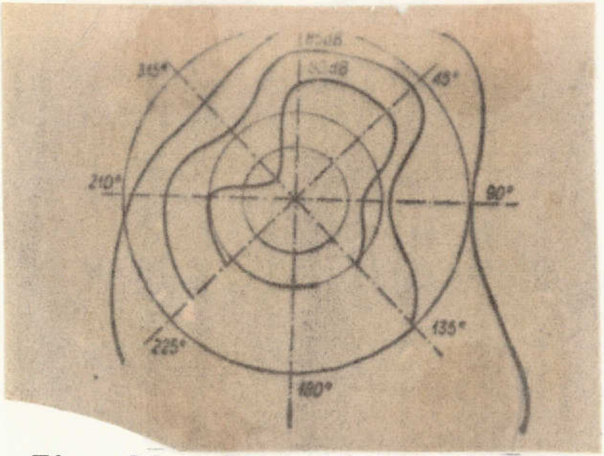

Fig. 10. Isosonic curves surrounding the plane with working jet engine under actual flight conditions.

these curves is somewhat complicated (Fig. 10). Besides the off-center placement of the engine intake, this picture shows the strong influence of directional effects of the streaming exhaust gases.

In contrast to results obtained outside the cabin, jet propulsion had the disadvantage, in comparison to piston propulsion, of greater noise outside the plane, i.e. noise within the visual range affecting the environment. To be sure, for acceptable conditions of actual flight, the jet engine is still imperceptibly less noisy, but,under cross-country conditions and even more during starting, the noise of the jet engine is greater.

The results presented here presage the initial phase of acoustical research in the direction of possible effective measures of noise abatement both outside and inside future agricultural aircraft.